1. A method for non-invasively determining a blood oxygen saturation level within a subject's tissue using a near infrared spectrophotometric sensor, said method comprising the steps of:

transmitting a light signal into the subject's tissue using the sensor, wherein the transmitted light signal includes a first wavelength, a second wavelength, and a third wavelength;

sensing a first intensity and a second intensity of the light signal, using the sensor, along the first, second, and third wavelengths after the light signal travels through the subject at a first predetermined distance and a second predetermined distance;

wherein the sensor is calibrated using empirical data that relates to the subject's tissue that is sensed by the sensor to account for light signal attenuation resulting from light signal scattering within the subject's tissue;

determining an attenuation of the light signal for each of the first, second, and third wavelengths using the sensed first intensity and sensed second intensity of the first, second, and third wavelengths;

determining a difference in attenuation of the light signal between the first wavelength and the second wavelength, and between the first wavelength and the third wavelength;

determining the blood oxygen saturation level within the subject's tissue using the difference in attenuation between the first wavelength and the second wavelength, and the difference in attenuation between the first wavelength and the third wavelength.

2. The method of claim 1, wherein the sensor is calibrated using equation: $SmvO_2 = Kv*SvO_2 + Ka*SaO_2$.

3. The method of claim 2, wherein the sensor is calibrated by using empirical data to determine a first calibration constant and a second calibration constant.

4. The method of claim 3, wherein the step of determining the blood oxygen saturation level within the subject's tissue utilizes the equation:

$$SnO_2\% = \frac{(A_{HbO_2} - \Psi_{HbO_2})}{(A_{HbO_2} - \Psi_{HbO_2} + A_{Hb} - \Psi_{Hb})} * 100\%$$

where $\Psi_{HbO2}$ represents the first calibration constant, $\Psi_{Hb}$ represents the second calibration constant, $A_{HbO2}$ represents a difference in attenuation of light signal attributable to oxyhemoglobin, and $A_{Hb}$ represents a difference in attenuation of light signal attributable to deoxyhemoglobin.

5. The method of claim 4, further comprising the steps of:

determining a photon pathlength $L_b$; and

determining a concentration of oxyhemoglobin and a concentration of deoxyhemoglobin within the subject's tissue using the first and second calibration constants.

6. The method of claim 5, wherein the concentration of oxyhemoglobin and the concentration of deoxyhemoglobin within the subject's tissue are determined using the equation:

$$\begin{bmatrix} A_{Hb} \\ A_{HbO_2} \end{bmatrix} (L_b)^{-1} - \begin{bmatrix} \Psi_{Hb} \\ \Psi_{HbO_2} \end{bmatrix} (L_b)^{-1} = \begin{bmatrix} [Hb]_b \\ [HbO_2]_b \end{bmatrix}.$$

7. The method of claim 6, wherein the step of determining a difference in attenuation of the light signal between the first wavelength and the second wavelength utilizes the equation:

$$\begin{aligned}\Delta A'_{12} &= A'_1 - A'_2 = -\log(I_b/I_x)_1 + \log(I_b/I_x)_2 \\ &= \{(\alpha_{r1} - \alpha_{r2})[Hb]_b + (\alpha_{o1} - \alpha_{o2})[HbO_2]_b\}L_b + (E'_1 - E'_2). \\ &= (\Delta\alpha_{r12}[Hb]_b + \Delta\alpha_{o12}[HbO_2]_b)L_b + \Delta E_{12}\end{aligned}$$

and the step of determining a difference in attenuation of the light signal between the first wavelength and the third wavelength utilizes the equation:

$$\begin{aligned}\Delta A'_{13} &= A'_1 - A'_3 = -\log(I_b/I_x)_1 + \log(I_b/I_x)_3 \\ &= \{(\alpha_{r1} - \alpha_{r3})[Hb]_b + (\alpha_{o1} - \alpha_{o3})[HbO_2]_b\}L_b + (E'_1 - E'_3). \\ &= (\Delta\alpha_{r13}[Hb]_b + \Delta\alpha_{o13}[HbO_2]_b)L_b + \Delta E_{13}\end{aligned}$$

8. The method of claim 7, wherein the step of determining an attenuation of the light signal utilizes the equation:

$$\begin{aligned}A'_\lambda &= -\log(I_b/I_x)_\lambda = (\alpha_{r\lambda}[Hb]_b + \alpha_{o\lambda}[HbO_2]_b)L_b + E'_\lambda \\ &= (\alpha_{r\lambda}[Hb]_b + \alpha_{o\lambda}[HbO_2]_b)L_b + (E - E_x)_\lambda\end{aligned}$$

for one or more of the first, second, and third wavelengths.

9. The method of claim 1, wherein the step of determining a difference in attenuation of the light signal between the first wavelength and the second wavelength utilizes the equation:

$$\begin{aligned}\Delta A'_{12} &= A'_1 - A'_2 = -\log(I_b/I_x)_1 + \log(I_b/I_x)_2 \\ &= \{(\alpha_{r1} - \alpha_{r2})[Hb]_b + (\alpha_{o1} - \alpha_{o2})[HbO_2]_b\}L_b + (E'_1 - E'_2) \\ &= (\Delta\alpha_{r12}[Hb]_b + \Delta\alpha_{o12}[HbO_2]_b)L_b + \Delta E_{12}\end{aligned}$$

and the step of determining a difference in attenuation of the light signal between the first wavelength and the third wavelength utilizes the equation:

$$\begin{aligned}\Delta A'_{13} &= A'_1 - A'_3 = -\log(I_b/I_x)_1 + \log(I_b/I_x)_3 \\ &= \{(\alpha_{r1} - \alpha_{r3})[Hb]_b + (\alpha_{o1} - \alpha_{o3})[HbO_2]_b\}L_b + (E'_1 - E'_3) \\ &= (\Delta\alpha_{r13}[Hb]_b + \Delta\alpha_{o13}[HbO_2]_b)L_b + \Delta E_{13}\end{aligned}$$

10. The method of claim 9, wherein the step of determining an attenuation of the light signal of a wavelength $\lambda$ utilizes the equation:

$$\begin{aligned}A'_\lambda &= -\log(I_b/I_x)_\lambda = (\alpha_{r\lambda}[Hb]_b + \alpha_{o\lambda}[HbO_2]_b)L'_b + E'_\lambda \\ &= (\alpha_{r\lambda}[Hb]_b + \alpha_{o\lambda}[HbO_2]_b)L_b + (E - E_x)_\lambda\end{aligned}$$

11. A method for determining a blood oxygen saturation level within a subject's tissue using a near infrared spectrophotometric sensor attached to the skin of the subject, said method comprising the steps of:

transmitting a light signal into the subject's tissue, wherein the transmitted light signal includes a first wavelength, a second wavelength, and a third wavelength;

sensing a first intensity and a second intensity of the light signal, using the sensor, along the first, second, and third wavelengths after the light signal travels through the subject at a first predetermined distance and a second predetermined distance;

determining an attenuation of the light signal for each of the first, second, and third wavelengths using the first intensity and the sensed second intensity of the first, second, and third wavelengths;

determining a difference in attenuation of the light signal between the first wavelength and the second wavelength, and between the first wavelength and the third wavelength;

determining a first calibration constant and a second calibration constant using empirical data developed from the subject at or about the same time as when the sensing occurs;

determining the blood oxygen saturation level within the subject's tissue using the difference in attenuation between the first wavelength and the second wavelength, and the difference in attenuation between the first wavelength and the third wavelength, and the first calibration constant and the second calibration constant.

12. The method of claim 11 wherein the empirical data is collected by discretely sampling a venous blood source and an arterial blood source from the subject.

13. The method of claim 11 wherein the empirical data is collected by continuously monitoring a venous blood source and an arterial blood source from the subject.

14. The method of claim 11, wherein the sensor is calibrated using equation: $SmvO_2 = Kv*SvO_2 + Ka*SaO_2$.

15. The method of claim 14, wherein the step of determining the blood oxygen saturation level within the subject's tissue utilizes the equation:

$$SnO_2\% = \frac{(A_{HbO_2} - \Psi_{HbO_2})}{(A_{HbO_2} - \Psi_{HbO_2} + A_{Hb} - \Psi_{Hb})} * 100\%.$$

where $\Psi_{HbO2}$ represents the first calibration constant, $\Psi_{Hb}$ represents the second calibration constant, $A_{HbO2}$ represents a difference in attenuation of light signal attributable to oxyhemoglobin, and $A_{Hb}$ represents a difference in attenuation of light signal attributable to deoxyhemoglobin..

16. The method of claim 15, further comprising the steps of:

determining a photon pathlength $L_b$; and

determining the concentration of oxyhemoglobin and deoxyhemoglobin within the subject's tissue using the first and second calibration constants.

17. The method of claim 16, wherein the concentration of oxyhemoglobin and deoxyhemoglobin within the subject's tissue are determined using the equation:

$$\begin{bmatrix} A_{Hb} \\ A_{HbO_2} \end{bmatrix} (L_b)^{-1} - \begin{bmatrix} \Psi_{Hb} \\ \Psi_{HbO_2} \end{bmatrix} (L_b)^{-1} = \begin{bmatrix} Hb \\ HbO_2 \end{bmatrix}.$$

18. The method of claim 17, wherein the step of determining a difference in attenuation of the light signal between the first wavelength and the second wavelength utilizes the equation:

$$\begin{aligned}\Delta A'_{12} = A'_1 - A'_2 &= -\log(I_b/I_x)_1 + \log(I_b/I_x)_2 \\ &= \{(\alpha_{r1} - \alpha_{r2})[Hb]_b + (\alpha_{o1} - \alpha_{o2})[HbO_2]_b\}L_b + (E'_1 - E'_2) \\ &= (\Delta\alpha_{r12}[Hb]_b + \Delta\alpha_{o12}[HbO_2]_b)L_b + \Delta E_{12}\end{aligned}$$

and the step of determining a difference in attenuation of the light signal between the first wavelength and the third wavelength utilizes the equation:

$$\begin{aligned}\Delta A'_{13} = A'_1 - A'_3 &= -\log(I_b/I_x)_1 + \log(I_b/I_x)_3 \\ &= \{(\alpha_{r1} - \alpha_{r3})[Hb]_b + (\alpha_{o1} - \alpha_{o3})[HbO_2]_b\}L_b + (E'_1 - E'_3) \\ &= (\Delta\alpha_{r13}[Hb]_b + \Delta\alpha_{o13}[HbO_2]_b)L_b + \Delta E_{13}\end{aligned}$$

19. The method of claim 18, wherein the step of determining an attenuation of the light signal utilizes the equation:

$$\begin{aligned}A'_\lambda &= -\log(I_b/I_x)_\lambda = (\alpha_{r\lambda}[Hb]_b + \alpha_{o\lambda}[HbO_2]_b)L_b + E'_\lambda \\ &= (\alpha_{r\lambda}[Hb]_b + \alpha_{o\lambda}[HbO_2]_b)L_b + (E - E_x)_\lambda\end{aligned}$$

for one or more of the first, second, and third wavelengths.

20. The method of claim 11, wherein the step of determining a difference in attenuation of the light signal between the first wavelength and the second wavelength utilizes the equation:

$$\begin{aligned}\Delta A'_{12} &= A'_1 - A'_2 = -\log({}^{I_b}/_{I_x})_1 + \log({}^{I_b}/_{I_x})_2 \\ &= \{(\alpha_{r1} - \alpha_{r2})[Hb]_b + (\alpha_{o1} - \alpha_{o2})[HbO_2]_b\}L_b + (E'_1 - E'_2) \\ &= (\Delta\alpha_{r12}[Hb]_b + \Delta\alpha_{o12}[HbO_2]_b)L_b + \Delta E_{12}\end{aligned}$$

and the step of determining a difference in attenuation of the light signal between the first wavelength and the third wavelength utilizes the equation:

$$\begin{aligned}\Delta A'_{13} &= A'_1 - A'_3 = -\log({}^{I_b}/_{I_x})_1 + \log({}^{I_b}/_{I_x})_3 \\ &= \{(\alpha_{r1} - \alpha_{r3})[Hb]_b + (\alpha_{o1} - \alpha_{o3})[HbO_2]_b\}L_b + (E'_1 - E'_3) \\ &= (\Delta\alpha_{r13}[Hb]_b + \Delta\alpha_{o13}[HbO_2]_b)L_b + \Delta E_{13}\end{aligned}$$

21. The method of claim 20, wherein the step of determining a attenuation of the light signal utilizes the equation:

$$\begin{aligned}A'_\lambda &= -\log({}^{I_b}/_{I_x})_\lambda = (\alpha_{r\lambda}[Hb]_b + \alpha_{o\lambda}[HbO_2]_b)L_b + E'_\lambda \\ &= (\alpha_{r\lambda}[Hb]_b + \alpha_{o\lambda}[HbO_2]_b)L_b + (E - E_x)_\lambda\end{aligned}$$

for one or more of the first, second, and third wavelengths.

22. The method of claim 11, wherein the step of determining the blood oxygen saturation level within the subject's tissue utilizes the equation:

$$SnO_2\% = \frac{(A_{HbO_2} - \Psi_{HbO_2})}{(A_{HbO_2} - \Psi_{HbO_2} + A_{Hb} - \Psi_{Hb})} * 100\%$$

where $\Psi_{HbO2}$ represents the first calibration constant, $\Psi_{Hb}$ represents the second calibration constant, $A_{HbO2}$ represents a difference in attenuation of light signal attributable to oxyhemoglobin, and $A_{Hb}$ represents a difference in attenuation of light signal attributable to deoxyhemoglobin.

23. The method of claim 22, further comprising the steps of:

determining a photon pathlength $L_b$, and

determining the concentration of oxyhemoglobin and deoxyhemoglobin within the subject's tissue using the first and second calibration constants.

24. The method of claim 23, wherein the concentration of oxyhemoglobin and deoxyhemoglobin within the subject's tissue are determined using the equation:

$$\begin{bmatrix} A_{Hb} \\ A_{HbO_2} \end{bmatrix} (L_b)^{-1} - \begin{bmatrix} \Psi_{Hb} \\ \Psi_{HbO_2} \end{bmatrix} (L_b)^{-1} = \begin{bmatrix} Hb \\ HbO_2 \end{bmatrix}.$$

25. The method of claim 24, wherein the step of determining a difference in attenuation of the light signal between the first wavelength and the second wavelength utilizes the equation:

$$\begin{aligned}\Delta A'_{12} &= A'_1 - A'_2 = -\log(I_b/I_x)_1 + \log(I_b/I_x)_2 \\ &= \{(\alpha_{r1} - \alpha_{r2})[Hb]_b + (\alpha_{o1} - \alpha_{o2})[HbO_2]_b\}L_b + (E'_1 - E'_2) \\ &= (\Delta\alpha_{r12}[Hb]_b + \Delta\alpha_{o12}[HbO_2]_b)L_b + \Delta E_{12}\end{aligned}$$

and the step of determining a difference in attenuation of the light signal between the first wavelength and the third wavelength utilizes the equation:

$$\begin{aligned}\Delta A'_{13} &= A'_1 - A'_3 = -\log(I_b/I_x)_1 + \log(I_b/I_x)_3 \\ &= \{(\alpha_{r1} - \alpha_{r3})[Hb]_b + (\alpha_{o1} - \alpha_{o3})[HbO_2]_b\}L_b + (E'_1 - E'_3) \\ &= (\Delta\alpha_{r13}[Hb]_b + \Delta\alpha_{o13}[HbO_2]_b)L_b + \Delta E_{13}\end{aligned}$$

26. The method of claim 25, wherein the step of determining an attenuation of the light signal utilizes the equation:

$$\begin{aligned}A'_\lambda &= -\log(I_b/I_x)_\lambda = (\alpha_{r\lambda}[Hb]_b + \alpha_{o\lambda}[HbO_2]_b)L_b + E'_\lambda \\ &= (\alpha_{r\lambda}[Hb]_b + \alpha_{o\lambda}[HbO_2]_b)L_b + (E - E_x)_\lambda\end{aligned}$$

for one or more of the first, second, and third wavelengths.

27. A method for calibrating a near infrared spectrophotometric sensor for use in determining the blood oxygen saturation level within a subject's tissue, said method comprising the steps of:

transmitting a light signal into the subject's tissue, wherein the transmitted light signal includes a first wavelength, a second wavelength, and a third wavelength;

sensing a first intensity and a second intensity of the light signal, using the sensor, along the first, second, and third wavelengths after the light signal travels through the subject at a first and second predetermined distances;

determining an attenuation of the light signal for each of the first, second, and third wavelengths using the first intensity and the sensed second intensity of the first, second, and third wavelengths;

determining a difference in attenuation of the light signal between the first wavelength and the second wavelength, and between the first wavelength and the third wavelength;

determining a first calibration constant and a second calibration constant using empirical data developed from the subject at or about the same time as when the sensing occurs; and

calibrating the sensor using the first calibration constant and the second calibration constant.

28. The method of claim 27, wherein the empirical data is collected by discretely sampling a venous blood source and an arterial blood source from the subject.

29. The method of claim 27, wherein the empirical data is collected by continuously monitoring a venous blood source and an arterial blood source from the subject.

30. The method of claim 27, wherein the sensor is calibrated using equation: $SmvO_2 = Kv*SvO_2 + Ka*SaO_2$.

31. The method of claim 30, wherein the step of determining the blood oxygen saturation level within the subject's tissue utilizes the equation:

$$SnO_2\% = \frac{(A_{HbO_2} - \Psi_{HbO_2})}{(A_{HbO_2} - \Psi_{HbO_2} + A_{Hb} - \Psi_{Hb})} * 100\%.$$

where $\Psi_{HbO2}$ represents the first calibration constant, $\Psi_{Hb}$ represents the second calibration constant, $A_{HbO2}$ represents a difference in attenuation of light signal attributable to oxyhemoglobin, and $A_{Hb}$ represents a difference in attenuation of light signal attributable to deoxyhemoglobin..

32. The method of claim 31, further comprising the steps of:

determining a photon pathlength $L_b$, and

determining the concentration of oxyhemoglobin and deoxyhemoglobin within the subject's tissue using the first and second calibration constants.

33. The method of claim 32, wherein the concentration of oxyhemoglobin and deoxyhemoglobin within the subject's tissue are determined using the equation:

$$\begin{bmatrix} A_{Hb} \\ A_{HbO_2} \end{bmatrix} (L_b)^{-1} - \begin{bmatrix} \Psi_{Hb} \\ \Psi_{HbO_2} \end{bmatrix} (L_b)^{-1} = \begin{bmatrix} Hb \\ HbO_2 \end{bmatrix}.$$

34. The method of claim 33, wherein the step of determining a difference in attenuation of the light signal between the first wavelength and the second wavelength utilizes the equation:

$$\begin{aligned}\Delta A'_{12} &= A'_{\lambda 1} - A'_{\lambda 2} = -\log\left({}^{I_b}\!/_{I_x}\right)_1 + \log\left({}^{I_b}\!/_{I_x}\right)_2 \\ &= \{(\alpha_{r1} - \alpha_{r2})[Hb]_b + (\alpha_{o1} - \alpha_{o2})[HbO_2]_b\}L_b + (E'_1 - E'_2) \\ &= (\Delta\alpha_{r12}[Hb]_b + \Delta\alpha_{o12}[HbO_2]_b)L_b + \Delta E_{12}\end{aligned}$$

and the step of determining a difference in attenuation of the light signal between the first wavelength and the third wavelength utilizes the equation:

$$\begin{aligned}\Delta A'_{13} &= A'_{\lambda 1} - A'_{\lambda 3} = -\log\left({}^{I_b}\!/_{I_x}\right)_1 + \log\left({}^{I_b}\!/_{I_x}\right)_3 \\ &= \{(\alpha_{r1} - \alpha_{r3})[Hb]_b + (\alpha_{o1} - \alpha_{o3})[HbO_2]_b\}L_b + (E'_1 - E'_3) \\ &= (\Delta\alpha_{r13}[Hb]_b + \Delta\alpha_{o13}[HbO_2]_b)L_b + \Delta E_{13}\end{aligned}$$

35. The method of claim 34, wherein the step of determining an attenuation of the light signal utilizes the equation:

$$\begin{aligned}A'_\lambda &= -\log\left({}^{I_b}\!/_{I_x}\right)_\lambda = (\alpha_{r\lambda}[Hb]_b + \alpha_{o\lambda}[HbO_2]_b)L_b + E'_\lambda \\ &= (\alpha_{r\lambda}[Hb]_b + \alpha_{o\lambda}[HbO_2]_b)L_b + (E - E_x)_\lambda\end{aligned}$$

for one or more of the first, second, and third wavelengths.

36. A method for calibrating a NIRS sensor, said method comprising the steps of:

transmitting a first light signal from a calibrated NIRS sensor into a reference sample, wherein the transmitted first light signal includes a first wavelength, a second wavelength, and a third wavelength;

sensing a first intensity and a second intensity of the first light signal with the calibrated NIRS sensor along the first, second, and third wavelengths after the first light signal travels through the reference sample;

determining a first attenuation of the first light signal for each of the first, second, and third wavelengths using the first intensity and the second intensity of the first light signal sensed with the calibrated NIRS sensor;

transmitting a second light signal from an uncalibrated second NIRS sensor into the reference sample at a predetermined first intensity, wherein the transmitted second light signal includes a first wavelength, a second wavelength, and a third wavelength;

sensing a second intensity of the second light signal with the uncalibrated second NIRS sensor along the first, second, and third wavelengths after the second light signal travels through the subject;

determining a second attenuation of the second light signal for each of the first, second, and third wavelengths using the predetermined first intensity and the second intensity of the first, second, and third wavelengths sensed with the uncalibrated second NIRS sensor;

adjusting the uncalibrated second NIRS sensor so that the second attenuation substantially agrees with the first attenuation.

37. A method for non-invasively determining a concentration of oxyhemoglobin and a concentration of deoxyhemoglobin within a subject's tissue using a near infrared spectrophotometric sensor, said method comprising the steps of:

(a) determining a blood oxygen saturation level with the subject's tissue by

transmitting a light signal into the subject's tissue from a NIRS sensor, wherein the transmitted light signal includes a first wavelength, a second wavelength, and a third wavelength;

sensing a first intensity and a second intensity of the light signal, using the sensor, along the first, second, and third wavelengths after the light signal travels through the subject at a first and second predetermined distances;

wherein the sensor is calibrated using empirical data that relates to the subject's tissue that is sensed by the sensor to account for light signal attenuation resulting from light signal scattering within the subject's tissue;

determining an attenuation of the light signal for each of the first, second, and third wavelengths using the first intensity and the sensed second intensity of the first, second, and third wavelengths;

determining a difference in attenuation of the light signal between the first wavelength and the second wavelength, and between the first wavelength and the third wavelength;

determining a first calibration constant and a second calibration constant using empirical data developed from the subject at or about the same time as when the sensing occurs;

determining the blood oxygen saturation level within the subject's tissue using the difference in attenuation between the first wavelength and the second wavelength, and the difference in attenuation between the first wavelength and the third wavelength, and the first calibration constant and the second calibration constant;

(b) determining a photon pathlength $L_b$, and

(c) determining the concentration of oxyhemoglobin and the concentration of deoxyhemoglobin within the subject's tissue using the first and second calibration constants.

38. The method of claim 37, wherein the concentration of oxyhemoglobin and the concentration of deoxyhemoglobin within the subject's tissue are determined using the equation:

$$\begin{bmatrix} A_{Hb} \\ A_{HbO_2} \end{bmatrix} (L_b)^{-1} - \begin{bmatrix} \Psi_{Hb} \\ \Psi_{HbO_2} \end{bmatrix} (L_b)^{-1} = \begin{bmatrix} Hb \\ HbO_2 \end{bmatrix}.$$

where $\Psi_{HbO2}$ represents the first calibration constant, $\Psi_{Hb}$ represents the second calibration constant, $A_{HbO2}$ represents a difference in attenuation of light signal attributable to oxyhemoglobin, and $A_{Hb}$ represents a difference in attenuation of light signal attributable to deoxyhemoglobin.

39. A method for non-invasively determining a concentration of oxyhemoglobin and a concentration of deoxyhemoglobin within a subject's tissue at an initial time *t1* and a subsequent time *t2* using a near infrared spectrophotometric sensor, said method comprising the steps of:

(a) determining a blood oxygen saturation level with the subject's tissue by

transmitting a light signal into the subject's tissue from a NIRS sensor, wherein the transmitted light signal includes a first wavelength, a second wavelength, and a third wavelength;

sensing a first intensity and a second intensity of the light signal, using the sensor, along the first, second, and third wavelengths after the light signal travels through the subject at a first and second predetermined distances;

wherein the sensor is calibrated using empirical data that relates to the subject's tissue that is sensed by the sensor to account for light signal attenuation resulting from light signal scattering within the subject's tissue;

determining an attenuation of the light signal for each of the first, second, and third wavelengths using the first intensity and the sensed second intensity of the first, second, and third wavelengths;

determining a difference in attenuation of the light signal between the first wavelength and the second wavelength, and between the first wavelength and the third wavelength;

determining a first calibration constant and a second calibration constant using empirical data developed from the subject at or about the same time as when the sensing occurs;

determining the blood oxygen saturation level within the subject's tissue using the difference in attenuation between the first wavelength and the second wavelength, and the difference in attenuation between the first wavelength and the third wavelength, and the first calibration constant and the second calibration constant;

(b) determining a photon pathlength $L_b$;

(c) determining the concentration of oxyhemoglobin and the concentration of deoxyhemoglobin within the subject's tissue at the initial time t1 using the equation:

$$\begin{bmatrix} A_{Hb} \\ A_{HbO_2} \end{bmatrix} (L_b)^{-1} - \begin{bmatrix} \Psi_{Hb} \\ \Psi_{HbO_2} \end{bmatrix} (L_b)^{-1} = \begin{bmatrix} Hb \\ HbO_2 \end{bmatrix}$$

where $\Psi_{HbO2}$ represents the first calibration constant, $\Psi_{Hb}$ represents the second calibration constant, $A_{HbO2}$ represents a difference in attenuation of light signal attributable to oxyhemoglobin, and $A_{Hb}$ represents a difference in attenuation of light signal attributable to deoxyhemoglobin; and

(d) determining a change in the concentration of oxyhemoglobin and a change in the concentration of deoxyhemoglobin from the initial time *t1* to a subsequent second time *t2*, determined using the equation:

$$\begin{bmatrix} -\log(I_{t2}/I_{t1})_{\lambda 1}/L_{\lambda 1} \\ -\log(I_{t2}/I_{t1})_{\lambda 2}/L_{\lambda 2} \\ -\log(I_{t2}/I_{t1})_{\lambda 3}/L_{\lambda 3} \end{bmatrix} = \begin{bmatrix} \alpha_{Hb\lambda 1} & \alpha_{HbO_2\lambda 1} \\ \alpha_{Hb\lambda 2} & \alpha_{HbO_2\lambda 2} \\ \alpha_{Hb\lambda 3} & \alpha_{HbO_2\lambda 3} \end{bmatrix} * \begin{bmatrix} \Delta Hb \\ \Delta HbO_2 \end{bmatrix}$$

;and

(e) determining the concentration of oxyhemoglobin and the concentration of deoxyhemoglobin within the subject's tissue at the subsequent time *t2* using the equations:

$$[Hb]_{t_2} = \Delta Hb(t_2) + [Hb]_{t_1}$$ and

$$[HbO_2]_{t_2} = \Delta HbO_2(t_2) + [HbO_2]_{t_1}.$$

40. A method for non-invasively determining a blood oxygen saturation level within a subject's tissue using a near infrared spectrophotometric sensor, said method comprising the steps of:

transmitting a light signal into the subject's tissue using the sensor;

sensing a first intensity and a second intensity of the light signal, using the sensor, along the three or more selectively chosen wavelengths after the light signal travels through the subject at a first and second predetermined distances;

wherein the sensor is calibrated using empirical data that relates to the subject's tissue that is sensed by the sensor to account for light signal attenuation resulting from light signal scattering within the subject's tissue;

determining an attenuation of the light signal for at least "n" number of the selectively chosen wavelengths using the first intensity and the sensed second intensity of the selectively chosen wavelengths, where "n" is an integer equal to or greater than three;

determining a difference in attenuation of the light signal between a first wavelength and each of "n" number of the selectively chosen wavelengths;

determining the blood oxygen saturation level within the subject's tissue using the difference in attenuation between the first wavelength and each of the "n" number of other selectively chosen wavelengths.

41. A method for determining a blood oxygen saturation level within a subject's tissue using a near infrared spectrophotometric sensor attached to the skin of the subject, said method comprising the steps of:

transmitting a light signal into the subject's tissue;

sensing a first intensity and a second intensity of the light signal, using the sensor, along three or more selectively chosen wavelengths after the light signal travels through the subject at a first and second predetermined distances;

determining an attenuation of the light signal for at least "n" number of the selectively chosen wavelengths using the first intensity and the sensed second intensity of the selectively chosen wavelengths, where "n" is an integer equal to or greater than three;

determining a difference in attenuation of the light signal between a first wavelength and each of "n" number of the selectively chosen wavelengths;

determining a first calibration constant and a second calibration constant using empirical data developed from the subject at or about the same time as when the sensing occurs;

determining the blood oxygen saturation level within the subject's tissue using the difference in attenuation between the first wavelength and each of "n" number of the selectively chosen wavelengths, and the first calibration constant and the second calibration constant.

42. A method for non-invasively determining a blood oxygen saturation level within a subject's tissue using a near infrared spectrophotometric sensor, said method comprising the steps of:

transmitting a light signal into the subject's tissue using the sensor, wherein the transmitted light signal includes a first wavelength, and a second wavelength;

sensing a first intensity and a second intensity of the light signal, using the sensor, along the first wavelength, after the light signal travels through the subject at a first and a second predetermined distances;

sensing a third intensity and a fourth intensity of the light signal, using the sensor, along the second wavelength, after the light signal travels through the subject at said first and said second predetermined distances;

wherein the sensor is calibrated using empirical data that relates to the subject's tissue that is sensed by the sensor to account for light signal attenuation resulting from light signal scattering within the subject's tissue;

determining a first attenuation of the light signal for the first wavelength using said first intensity and said second intensity;

determining a second attenuation of the light signal for the second wavelength using said third intensity and said fourth intensity;

determining a ratio of said first and said second attenuations of the light signal for the first, and second wavelengths;

determining the blood oxygen saturation level within the subject's tissue using said ratio.

43. The method of claim 42, wherein the sensor is calibrated using equation: $SmvO_2 = Kv*SvO_2 + Ka*SaO_2$.

44. The method of claim 43, wherein the sensor is calibrated by using empirical data to determine a first calibration constant and a second calibration constant.

45. The method of claim 44, wherein the step of determining the ratio $R$ of attenuations of the light signal for the first, and second wavelengths utilizes the equation:

$$R = \frac{A_1^{'} - E_1^{'}}{A_2^{'} - E_2^{'}}$$

where $E'_1$ represents the first calibration constant, $E'_2$ represents the second calibration constant, $A'_1$ represents the first attenuation of light signal of the first wavelength, and $A'_2$ represents the second attenuation of light signal of the second wavelength.

46. The method of claim 45, wherein the step of determining the first attenuation of the first wavelength utilizes the equation:

$$-\log({}^{I_b}/_{I_x})_1 = (\alpha_{r1}[Hb]_b + \alpha_{o1}[HbO_2]_b)L_b + (E - E_x)_1.$$

and the step of determining the second attenuation of the second wavelength utilizes the equation:

$$-\log({}^{I_b}/_{I_x})_2 = (\alpha_{r2}[Hb]_b + \alpha_{o2}[HbO_2]_b)L_b + (E - E_x)_2.$$

47. The method of claim 43, wherein the step of determining the blood oxygen saturation level within the subject's tissue utilizes the equation:

$$SnO_2\% = \frac{\alpha_{r1} - \alpha_{r2}R}{(\alpha_{r1} - \alpha_{o1}) + (\alpha_{o2} - \alpha_{r2})R} 100\%$$

where $R$ represents the ratio of attenuations of the light signal for each of the first, and second wavelengths.

48. The method of claim 47, wherein the step of determining the ratio $R$ of attenuations of the light signal for the first, and second wavelengths utilizes the equations:

$$R = \frac{A_1' - E_1'}{A_2' - E_2'}$$

where $E'_1$ represents the first calibration constant, $E'_2$ represents the second calibration constant, $A'_1$ represents the first attenuation of light signal of the first wavelength, and $A'_2$ represents the second attenuation of light signal of the second wavelength.

49. The method of claim 48, wherein the step of determining the first attenuation of the first wavelength utilizes the equation:

$$-\log(I_b/I_x)_1 = (\alpha_{r1}[Hb]_b + \alpha_{o1}[HbO_2]_b)L_b + (E - E_x)_1.$$

and the step of determining the second attenuation of the second wavelength utilizes the equation:

$$-\log(I_b/I_x)_2 = (\alpha_{r2}[Hb]_b + \alpha_{o2}[HbO_2]_b)L_b + (E - E_x)_2.$$

50. The method of claim 43, wherein the step of determining the blood oxygen saturation level within the subject's tissue comprising the steps of:

determining the attenuation ratio $R$ of the light signal for each of the first, and second wavelengths;

determining the blood oxygen saturation level utilizing an empirical obtained calibration curve defining the relationship between the said attenuation ratio $R$ with blood oxygen saturation.

51. The method of claim 50, wherein the step of determining the first attenuation of the first wavelength utilizes the equation:

$$A_1' = -\log(I_b/I_x)_1 = (\alpha_{r1}[Hb]_b + \alpha_{o1}[HbO_2]_b)L_b + E_1'.$$

and the step of determining the second attenuation of the second wavelength utilizes the equation:

$$A_2' = -\log(I_b/I_x)_2 = (\alpha_{r2}[Hb]_b + \alpha_{o2}[HbO_2]_b)L_b + E_2'.$$

52. The method of claim 43, further comprising the steps of:

determining a photon pathlength $L_b$; and

determining a concentration of oxyhemoglobin and a concentration of deoxyhemoglobin within the subject's tissue using the first and second calibration constants.

53. The method of claim 51, wherein the concentration of oxyhemoglobin and the concentration of deoxyhemoglobin within the subject's tissue are determined using the equation:

$$\begin{bmatrix} A_1' \\ A_2' \end{bmatrix} \begin{bmatrix} \alpha_{r1} & \alpha_{o1} \\ \alpha_{r2} & \alpha_{o2} \end{bmatrix}^{-1} (L_b)^{-1} - \begin{bmatrix} E_1' \\ E_2' \end{bmatrix} \begin{bmatrix} \alpha_{r1} & \alpha_{o1} \\ \alpha_{r2} & \alpha_{o2} \end{bmatrix}^{-1} (L_b)^{-1} = \begin{bmatrix} [Hb]_b \\ [HbO_2]_b \end{bmatrix}$$